VAN NOSTRAND'S SCIENTIFIC ENCYCLOPEDIA

Seventh Edition

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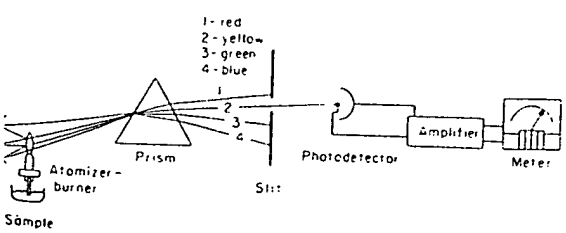
Underwater flame cutting is possible at depths of 135 feet (40.5
) or more using special practice.

E HARDENING. Surface hardening of steel or cast iron by
a thin surface layer to the hardening temperature with an oxy-
ne flame, followed by rapid cooling. Depending on the nature
part to be hardened, either the torch system or the work itself
moved. Cylindrical parts are rotated before a stationary flame.
jet or liquid spray following the torch is used to quench-harden
ace. The relatively cool metal in the interior hastens cooling of
ace by conduction. The depth of flame hardening may be less
inch to about $\frac{1}{4}$ inch (1.6–6 millimeters), depending on the thick-
the section and the service requirements. Distortion is generally
n in parts hardened by general heating and quenching.
no hardening agent such as carbon or nitrogen is added to the
of the steel by this process, only steels having sufficient carbon
n readily upon quenching are used for flame hardening. The
sirable range is 0.35–0.70% carbon. The hardening treatment
ed by a low-temperature tempering treatment to relieve quench-
ns. Typical applications of flame hardening are gear teeth, cams,
surfaces, rail ends, crankshafts, and many other machine parts
s.

PHOTOMETRY AND SPECTROMETRY. The basic prin-
lame emission spectrometry rests on the fact that salts of metals,
roduced under carefully controlled conditions into a suitable
e vaporized and excited to emit radiations that are characteristic
element. Correlation of the emission intensity with the concen-
that element forms the basis of quantitative evaluation.
terminations of sodium and potassium constitute the majority
hed applications. However, the flame is a suitable emission
r at least 45 elements, which may be grouped as follows:
ments determined: aluminum, barium, boron, calcium, cesium,
, copper, iron, lead, lithium, magnesium, manganese, potas-
idium, sodium, strontium.
nents determined but sometimes overlooked: antimony, arsenic,
cadmium, cobalt, gallium, indium, lanthanum, nickel, palla-
earths (except cerium), rhodium, ruthenium, scandium, sliver,
thallium, tin, and yttrium.
nents with distinctive but less sensitive flame spectra: beryl-
nanium, gold, mercury, molybdenum, niobium, rhenium, sele-
con, titanium, tungsten.
nents determined by indirect means: bromine, chlorine, fluo-
ie (although bromine, chlorine and fluorine can be determined
etallic halide spectra), phosphorus, and silicon.
ls in which these elements are determined by flame spec-
nclude water, glasses, cement, soils, fertilizers, plant materials,
fluids and tissues, petroleum products and metallurgical prod-

ne spectrometer, used in emission spectrometry, consists of
ssure regulators and flow meters for the fuel gases; (2) the
device; (3) the flame source; (4) the optical system; (5) appro-
osensitive detectors; and (6) the electrical circuit for measuring
ng the intensity of the radiation. Depending upon the use
he instrument may be a relatively simple assemblage of inter-
ers and a photo-detector, i.e., a flame photometer, or it may
rate prism or grating monochromator, i.e., a flame spectrome-
the instrument illustrated.
all flame spectrometers rely on atomization to deliver a
of solution to the flame. The solution is drawn through a
sitioned either concentric with or at right angles to the annulus



Flame spectrometer.

or capillary from which the aspirating gas (oxygen or air under pressure) enters. At the tip of the solution capillary, the liquid is sheared off and dispersed into droplets by the blast of oxygen or air.

The best isolation of radiant energy can be achieved with flame spectrometers that incorporate either a prism or grating monochromator, those with prisms having variable gauged entrance and exit slits. Both these spectrometers provide a continuous selection of wavelengths with resolving power sufficient to separate completely most of the easily excited emission lines, and afford freedom from scattered radiation sufficient to minimize interferences. Fused silica or quartz optical components are necessary to permit measurements in the ultraviolet portion of the spectrum below 350 nanometers. See also **Analysis (Chemical); Atomic Spectroscopy; Photometers;** and **Spectro Instruments.**

FLAME-RETARDING AGENTS. A material used as a coating on or a component of a combustible product to raise its ignition point. The protection provided is usually only partial, and most materials so treated will burn when exposed to sufficiently high temperatures. The three principal types of agents are: (1) *nondurable*, consisting of water-soluble inorganic salts, which are easily removed by washing or accidental exposure to water; (2) *semi-durable* (removed by repeated laundering or dry-cleaning); and (3) *durable* (not affected by laundering or dry-cleaning). The latter types include or have included in the past organic compounds of bromine and chlorine, and insoluble metal salts. Antimony trioxide, tricresyl phosphate and other phosphate esters, chlorendic acid, etc., are effective, as well as cellulose-reactive agents. Zinc carbonate in high volume concentration will render a rubber or plastic compound self-extinguishing.

In 1972, flammability standards for children's sleepwear were established in the United States. In an effort to confer flame-resistant properties to the fabrics used, manufacturers began to use a number of chemical additives, notably organic halogens or phosphate esters, or both. One of the most widely used was *tris*-(2,3-dibromopropyl)phosphate, commonly called tris-BP. Other closely associated compounds were used. At a considerably later date, some researchers found that tris-BP and related compounds were carcinogenic, among other negative qualities. There is much room for further research into finding effective flame retardants that do not have adverse side effects.

FLAMINGO (*Aves, Phoenicopteri*). Large wading birds of several species found in the warm regions of the world with the exception of Australia. They have very long legs and neck and a broad beak bent sharply downward at the middle. Red or rosy shades are characteristic in their plumage. Some authorities regard the flamingo as related ancestrally to ducks, geese, and swans. Only in comparatively recent years has the flamingo been placed in its own class, the *Phoenicopteriformes*. Flamingos are considered among the most beautiful of all birds—graceful, friendly, but gregarious. They range in length up to $6\frac{1}{2}$ feet (2 meters) and may be as much as 5 feet (1.5 meters) in height. Although these birds essentially are mute, they do make a chattering noise with their beak, which at times can become quite loud. In flight, the neck stretches forward and the legs slant backward to aid in their streamlining. Like some other water birds, the flamingo has a filtering mechanism as part of its bill. The bill is boxlike and can be used in the manner of a scoop. Nests are constructed of dirt and mud in the form of mounds from 12 to 16 inches (30–41 centimeters) in diameter. One or two chalk-white eggs are incubated by both parents. They require from 30 to 32 days to hatch. The chick is downy and able to run around almost immediately after hatching. When sleeping, the flamingo rests on one foot, drawing the other up into the feathers, with the knuckle part sticking out far behind. The flamingo is found from the Bahamas to South America and the Galapagos Islands. Some domesticated flocks are found in Florida. The birds also are found in the high Andes and in parts of France and Spain. The birds often fly in formation. See also **Phoenicopteri.**

FLANGE. A rim or projection extending completely around the object which is flanged. Thus, a flange is distinguished from an ear, which is a similar projection, but which extends only a small portion of the circumference. Flanges are employed for a great many different purposes, among which is the juncture of adjacent shafts by flanged couplings,